FEEDING HABITS OF METAMORPHOSED *AMBYSTOMA TIGRINUM MELANOSTICTUM* IN PONDS OF HIGH pH (> 9)

Brian T. Miller[1] and John H. Larsen, Jr.[1,2]

ABSTRACT.—During the spring breeding season throughout the channeled scablands of eastern Washington, metamorphosed male and female blotched tiger salamanders (*Ambystoma tigrinum melanostictum*) utilize oropharyngeal suction to capture large quantities of small aquatic invertebrates. Stomach content analysis on salamanders from three populations of this subspecies revealed that they consume the following taxa: Copepoda, Cladocera, Culicidae, Anostraca, and Chironomidae. Although the amount of energy obtained by adults via in-water feeding was not calculated, the large volume of aquatic invertebrate material flushed from salamander stomachs suggests that this feeding strategy should add significantly to their total annual nutrient consumption.

Investigations on the feeding habits of *Ambystoma tigrinum* have centered primarily on the diets of branchiate individuals. This ontogenetic stage, depending on individual size, season, and locality, feeds daily on large quantities of a variety of prey items (Olenick and Gee 1981, Brophy 1980, Dodson and Dodson 1971). As a result of their secretive terrestrial habits (Nussbaum et al. 1983, Smith 1961, Sever and Dineen 1978) similar information on diet and feeding for transformed individuals has been difficult to obtain. Reports on the feeding habits of this developmental stage are largely restricted to general accounts that list a variety of terrestrial invertebrates (most often those accepted by captive salamanders) as potential prey (Conant 1975, Nussbaum et al. 1983, Johnson 1977, Smith 1961). Since some metamorphosed *A. t. melanostictum* in central and eastern Washington remain in the ponds for considerable period of time as adults during the breeding season or as subadults immediately following transformation, such individuals could utilize the abundant aquatic invertebrate communities as an energy source.

In numerous locations larval *A. t. mavortium* metamorphose during late summer or early fall and remain in the ponds throughout the winter (Webb and Roueche 1971). The extent to which these transformed individuals feed during this period is unknown, but Webb and Roueche (1971) found aquatic prey in the stomachs of 13 subadults collected in the stomachs of 13 subadults collected in Dona Ana County, New Mexico, in February, and Burger (1950) reported that the principal item in the stomachs of adult *A. t. nebulosum* was the pond snail, *Lymnaea stagnalis*. Sexually mature, metamorphosed tiger salamanders return to the ponds to breed. Egg deposition typically occurs during late winter or early spring (Semlitsch 1983, Hassinger et al. 1970, Bishop 1943, Sever and Dineen 1978), whereas migrations to the ponds occur during spring and/or autumn (Semlitsch 1983, Stine 1984, Smith 1961). Even though transformed *A. tigrinum* may spend several months in the water, they reportedly feed very little if at all (Rose and Armentrout 1976, Stine 1984). However, we found the stomachs of transformed male and female *A. t. melanostictum*, collected from ponds in Washington State during the spring breeding season, often filled with aquatic invertebrates. The following reports on in-pond feeding by breeding congregations of transformed *A. t. melanostictum* and its possible significance.

MATERIALS AND METHODS

Transformed tiger salamanders were seined from three fish-free ponds in the channeled scablands of central and eastern Washington (14 April to 6 May 1984). This region is a network of scoured canyons and deep valleys carved out of basalt bedrock and loess by the Spokane flood of 20,000 years ago (Bretz

[1]Department of Zoology, Washington State University, Pullman, Washington 99164-4220.
[2]Electron Microscopy Center, Washington State University, Pullman, Washington 99164-4210.

1959). Thin soils characterize the scablands, and the dominant vegetation is a sagebrush (*Artemesia*)-wheatgrass (*Agropyron*) association (Daubenmire 1970). Nineteen salamanders were collected from a saline (300 mOs_m), alkaline (10.1 pH) pond in southern Grant County, 11 km from an alkaline (10.1 pH) pond of low salinity (<5 mOs_m) in southern Lincoln County, and 9 km from an ephemeral pond in northernWhitman County. Following capture the specimens were immediately immersed in an ice solution and returned to the laboratory, where they were either anesthetized in 1:1000 MS222 or frozen to −80 C. Stomach contents were obtained from either the anesthetized individuals using a flushing method modified after that of Legler and Sullivan (1979) or from the excised stomachs of the frozen animals. All stomach contents were stored in 70% ETOH until identified.

TABLE 1. Summary of stomach content analyses for metamorphosed *A. t. melanostictum* from eastern and central Washington ponds.

Percentage of stomachs containing taxon/ percentage of total items consumed / average number per stomach containing taxon	Lincoln Co. N = 11	Whitman Co. N = 9	Grant Co. N = 16
Copepoda	91/55/78	100/75/102	6/10/164
Cladocera	73/26/47	—	—
Anostraca	—	89/21/32	—
Ostracoda	73/04/06	67/02/03	—
Culicidae	9/ */01	—	100/45/044
Chironomidae	9/ */01	—	94/41/043
Trichoptera	73/06/11	33/01/04	—
Notonectidae	27/ */01	22/ */01	31/01/002
Corixidae	—	11/ */01	38/ */001
Odonata	9/ */01	—	13/ */001
Dytiscidae	82/03/05	78/02/04	19/02/009
Curculionidae	36/ */01	—	—
Gastropoda	45/05/14	—	—
Acarina	—	—	6/ */001

* < 0.5%

RESULTS AND DISCUSSION

Thirty-six (92%) of the 39 transformed *A. t. melanostictum* examined contained aquatic invertebrates in their stomachs; material in the remaining three individuals could not be identified. No apparent differences in the percentage of stomachs containing food were detected between males and females from any of the three populations. The structure of the aquatic invertebrate communities varies from pond to pond, and therefore the differences in the diets of these salamander populations reflect this factor.

The kinds of prey utilized by this subspecies in eastern Washington ponds are similar to those reported for various larval conspecifics (Brophy 1980, Dodson and Dodson 1981, Dineen 1955) and related larval congenerics (Branch and Altig, 1981). Although the total number of food items per stomach varied from 7 to 431 ($\bar{x}$ = 118), the most common prey eaten by salamanders inhabiting the ponds included: Copepoda and Cladocera (Lincoln County); Copepoda, Cladocera, and Anostroca (Whitman County); and Chironomidae and Culicidae (Grant County) (Table 1). Although not quantified, these invertebrates also composed the largest stomach content volume in the majority of water-collected salamanders. Therefore, small aquatic invertebrate taxa are responsible for the bulk of the diet of transformed adult *A. t. melanostictum* from the ponds investigated.

It is clear from our observations on metamorphosed *A. t. melanostictum* maintained in aquaria and supplied quantities of aquatic invertebrates that prey capture is accomplished by oropharyngeal suction, a nearly universal method of those vertebrates feeding in water (Bramble and Wake 1985). The large number of prey items present in the stomachs of both male and female transformed salamanders indicates that they feed extensively while in the ponds during the breeding season. This observation differs from that of Rose and Armentrout (1976); they rarely found food in the stomachs of metamorphosed *A. t. mavortium* collected from ponds. Smallwood (1928) determined that adult *A. maculatum* stop eating when they become aquatic during the breeding season, and Anderson (1968) reported that transformed male, but not female *A. macrodactylum* feed in the ponds.

The amount of time that *A. t. melanostictum* spends in water during the year is unknown. Therefore, the importance of energy obtained from in-water prey capture has not been determined. However, such feeding probably adds significantly to the total yearly energy intake, particularly within the channeled scablands of Washington where terrestrial conditions are harsh and land-living prey may be less readily available.

Metamorphosed *A. t. melanostictum* apparently spends long periods of time each year in these high pH ponds that readily support exploitable, abundant aquatic invertebrate communities and contain few predatory fish (Tillett 1984). This strategy is probably adaptive, since the terrain adjacent to these scabland ponds is, at best, marginal salamander habitat.

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